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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Paper No. 14

Application Number: 09/901,416
Filing Date: July 09, 2001
Appellant(s): XING ET AL.

Peter K. McLarty
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed August 22, 2003.

(1) Real Party in Interest

A statement identifying the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

A statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

(3) Status of Claims

The statement of the status of the claims contained in the brief is correct.

(4) Status of Amendments After Final

No amendment after final has been filed.

(5) Summary of Invention

The summary of invention contained in the brief is correct.

(6) Issues

The appellant's statement of the issues in the brief is correct.

(7) Grouping of Claims

Appellant's appeal brief include a statement of claims 1-13 stand or fall together.

(8) Claims Appealed

The copy of the appealed claims contained in the Appendix to the brief is correct.

(9) Prior Art of Record

6,410,437	FLANNER ET AL.	6-2002
6,399,512	BLOSSE ET AL.	6-2002

(10) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-13 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Flanner et al. (U.S. Patent No. 6,410,437) in view of Blosse et al. (U.S. Patent No. 6,399,512).

Regarding to claims 1-4, Flanner et al. teaches in figures 3-12 a method of forming interconnects comprising:

providing a silicon substrate (16) containing one or more electrically conductive devices (18),

forming a first dielectric layer (14) over the silicon substrate (16),

forming a second dielectric layer (8, 12, an OSG as claimed in claim 2, layer (10) is an optional layer therefore dielectric layer (8, and 12) are formed as a single unitary layer (see col. 5, lines 20-26)) over first dielectric layer (14), the dielectric constant of second dielectric layer is less than 3.0 (as claimed in claim 1, see col. 1, lines 28-47, organosilicate glass (OSG) low-k material dielectric constant is lower than 4.0),

forming a first hardmask layer (6, a silicon nitride (inorganic) cap layer is used as a masking layer to etch a trench (20) as shown in figures 7-8, as claimed in claim 4) over the second dielectric layer (8, 12, OSG),

forming a second mask layer (4, antireflective layer is used as a masking layer to etch a trench 20 as shown in figures 7-8) on the first hardmask layer (6),

Forming a trench (20) in the second dielectric layer (8, 12), and

Filling the trench with a conductive material (copper, see col. 8, lines 28-29, as claimed in claim 3).

Flanner teaches using an anti-reflective layer (4) as a mask to etch a trench (20) in second dielectric layer (8, 12) as shown in figures 7-8, but fails to teach that an antiflective layer is a hardmask layer (non-organic material) comprising a titanium nitride layer (TiN). Nevertheless, such processing step is known in the semiconductor processing art as evidenced by Blosse et al. Blosse et al. teaches a method of forming a contact trench structure by using an antireflective layer of TiN as a mask layer (see col. 5, lines 50-67). Since, TiN is an inorganic material (not an organic material, such as photoresist), hence it is a hardmask layer.

Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention was made would have used a TiN as a second hardmask layer in the process of Flanner et al. as taught by Blosse et al. ***because*** TiN layer functions as a masking layer to protect the underlying layer during trench etching and also as an antireflection material during photolithographic processing for greater resolution in photolithographic process to produce a contact trench structure with finer features for interconnects.

Regarding claims 5-8, Flanner teaches in figures 9-14 a method for forming interconnects comprising:

providing a silicon substrate (16) containing one or more electrically conductive devices (18),

forming a first dielectric layer (14) over the silicon substrate (16),

forming a second dielectric layer (8, 12, an OSG as claimed in claim 6, layer (10) is an optional layer, therefore dielectric layer (8, and 12) are formed as a single unitary layer (see col. 5, lines 20-26)) over first dielectric layer (14), the dielectric constant of second dielectric layer is less than 3.0 (as claimed in claim 5, see col. 1, lines 28-47, organosilicate glass (OSG) low-k material dielectric constant is lower than 4.0),

forming a first hardmask layer (6, a silicon nitride (inorganic) cap layer is used as a masking layer to etch a trench 20 as shown in figures 7-8, as claimed in claim 8) over the second dielectric layer (8, 12, OSG),

forming a second mask layer (4, antireflective layer is used as a masking layer to etch a trench 20 as shown in figure 10) on the first hardmask layer (6),

Etching a first opening in the second mask layer (4) of a first width (see figure 10),

Forming a first trench of a second width (see figure 10) in the second dielectric layer (8, and 12), the second width is less than the first width (see figure10),

Etching a second opening in the first hardmask layer (6) of a first width (see figure 11),

Forming a second trench of a first width in the second dielectric layer (8, 12), the second trench is positioned over the first trench (see figure 12, noted that layer 8 and 12 are formed as a single unitary layer), and

Filling first and second trenches with a conducting material (copper, see col. 8, lines 28-29, as claimed in claim 7).

Flanner teaches using an anti-reflective layer (4) as a mask to etch a trench (20) in second dielectric layer (8, 12) as shown in figures 9-10 but fails to teach that an antiflective layer is a hardmask layer (non-organic material) comprising a Titanium nitride layer (TiN). Nevertheless, such processing step is known in the semiconductor processing art as evidenced by Blosse et al. Blosse et al. teaches a method of forming a contact trench structure by using an antireflective layer of TiN as a mask layer (see col. 5, lines 50-67). Since, it is an inorganic material (not an organic material, such as photoresist), hence TiN is a hardmask layer.

Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention was made to use a TiN as a second hardmask layer in the process of Flanner et al. as taught by Blosse et al. ***because*** TiN layer functions as a masking layer to protect the underlying layer during trench etching and also has antireflection property during photolithographic process so that a greater resolution in photolithographic process is obtained to produce a contact trench structure for interconnects.

Regarding claims 9-13, Flanner teaches in figures 9-14, a method for forming interconnects, comprising:

providing a silicon substrate (16) containing one or more electrically conductive devices (18),

Forming a first etch stop layer (14) over the silicon layer (16),

Forming a first dielectric layer (12, OSG as claimed in claim 10) over the first etch stop layer (14), the dielectric constant of the first dielectric layer is less than 3.0 (as claimed in claim

9, see col. 1, lines 28-47, organosilicate glass (OSG) low-k material dielectric constant is lower than 4.0),

Forming a second etch stop layer (10) over the first dielectric layer (12),

Forming a second dielectric layer (8, OSG as claimed in claim 11) over the second etch stop layer (10), dielectric constant of second dielectric layer is less than 3.0 (as claimed in claim 9, see col. 1, lines 28-47, organosilicate glass (OSG) low-k material dielectric constant is lower than 4.0),

forming a first hardmask layer (6, a silicon nitride (inorganic) cap layer is used as a masking layer to etch a trench 20 as shown in figures 7-8, as claimed in claim 13) over the second dielectric layer (8),

forming a second mask layer (4, antireflective layer is used as a masking layer to etch a trench 20 as shown in figure 10) on the first hardmask layer (6),

Etching a first opening in the second hardmask layer (4) of a first width (see figure 10),

Forming a first trench of a second width in the second dielectric layer (8) , the second width is less than the first width (see figure 10),

Etching a second opening in the first hardmask layer (6) of a first width (see figure 11),

Forming a second trench of a first width in the second dielectric layer (8), second trench is positioned over the first trench (see figure 12),

Simultaneously etching second trench to a depth of the second etch stop layer (10) and first trench to a depth of the first etch stop layer (see figure 12), and

Filling the first and second trenches with a conducting material (copper, see col. 8, lines 28-29, as claimed in claim 12).

Flanner teaches using an anti-reflective layer (4) as a mask to etch a trench (20) in second dielectric layer (8, 12) as shown in figures 9-10 but fails to teach that an antiflective layer is a hardmask layer (non-organic material) comprising a Titanium nitride layer (TiN). Nevertheless, such processing step is known in the semiconductor processing art as evidenced by Blosse et al. Blosse et al. teaches a method of forming a contact trench structure by using an antireflective layer of TiN as a mask layer (see col. 5, lines 50-67). Since, TiN is an inorganic material (not an organic material, such as photoresist), it is a hardmask layer.

Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention was made to use TiN as a second hardmask layer in the process of Flanner et al. as taught by Blosse et al. ***because*** TiN layer functions as a masking layer to protect the underlying layer during trench etching and also has antireflection property during photolithographic process so that a greater resolution in photolithographic process is for contact trench structure for interconnects is produced.

(11) Response to Argument

Appellants contend that layer 6 of Flanner does not act as a mask layer. Further, layer 6 is merely part of a stack of layers that is etched using the photoresist layer 2 as an etch mask. This argument is not found to be persuasive because photoresist layer 2 in Flanner is used as a mask to form hardmask pattern from hardmask layers 4 and 6 in figure 3-6. Then, Flanner teaches using photoresist mask layer pattern 2 together with first hardmask patterned layer 6 and second hardmask patterned layer 4 in figure 6 to form a trench in first layer 14 and second

dielectric layer 8, 12. Flanner further teaches in figures 20 and 21 that after removing the photoresist layer 2, he uses only first and second hardmask patterned layers 4 and 6 as masks to remove the remaining portion (A) of dielectric layer 12 and dielectric 14 to form the trench/via. Therefore, it is clear that hardmask layers 4 and 6 are masks that are used for etching part of the underlying material exposed in the patterned layers 4, and 6, i.e., these layers are etching masks. Furthermore, the present claims do not preclude the inclusion of photoresist mask layer. Hence, the inclusion of additional process steps, such as photoresist mask layer 2 of Flanner, which aide in the trench etching process step to form a trench in the second dielectric layer 8, 12 as set forth in these claims is permissible. See ex parte Davis.

Appellants apparently concur that the term "comprises" allows for the inclusion of additional process steps. However, Appellants argue that the examiner is incorrect in the application this tenet of patent law to layers 4 and 6 of Flanner; that layers 4 and 6 are not hardmask layers because serve no masking function as that term is used in the instant invention. This argument is not found to be persuasive because Flanner clearly teaches in figures 20 and 21 that layer 4 and 6 are masking materials which allow the etching of the remaining portion (A) of dielectric layer 12 and dielectric layer 14 without the use of photoresist layer 2. Although not explicitly recited in the present claims, the instant specification shows in figures 1a to 1c a process that is similar to the Flanner's teaching by using photoresist mask layer 80 to form second hardmask pattern 60 and photoresist mask layer 85 which in turn form first hardmarsk pattern 50. Then, second dielectric layer 40 is etched by using photoresist mask layer 85 together with first and second hardmasks 50 and 60 to form a trench (see fig. 1c). In view of the arguments presented above and Appellants' failure to preclude photoresist layer from trench

etching process in the appalled claims 1-13, Appellants' argument that "the photoresist layer is not present during the trench etching step in the instant invention and the claims 1-13 cannot be properly rejected under 103(a) as being unpatentable over Flanner et al. in view of Blosse et al." is not persuasive.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Thanh T. Nguyen
Examiner
Art Unit 2813

Thanh Nguyen
November 17, 2003

Conferees

Carl Whitehead, Jr. (SPE)

Olik Chaudhuri (SPE)

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